Western Water Supply
-
NWS Forecast Services

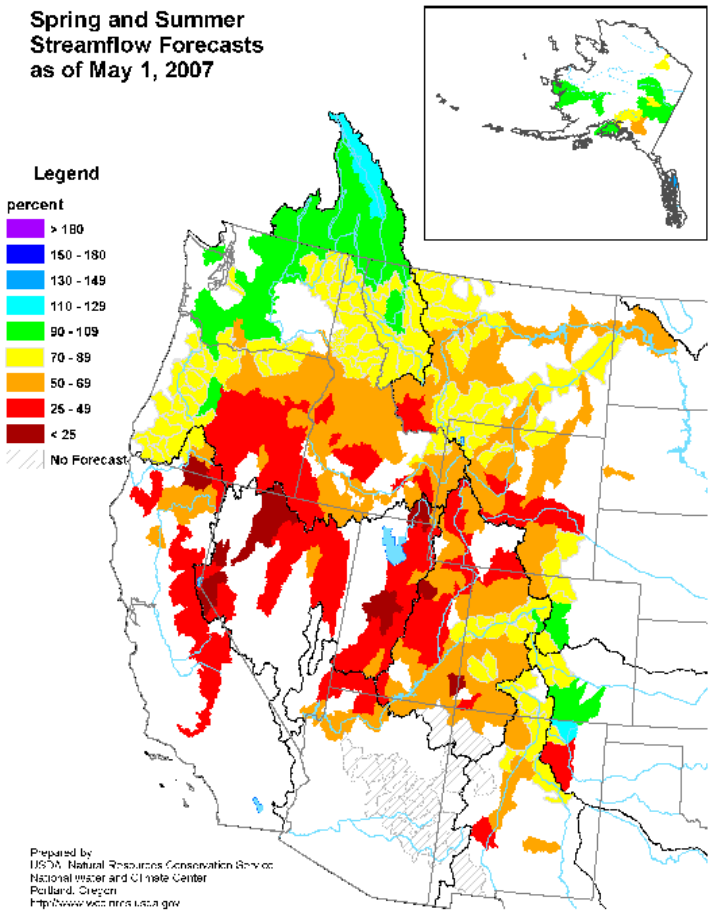
Kevin Werner, CBRFC
Andrew Murray, WR/SSD
Cass Goodman, Steve Shumate, CBRFC
Alan Takamoto, Scott Staggs, CNRFC
Don Laurine, NWRFC
Chad Kahler, WFO Tuscon
Jay Breidenbach, WFO Boise
Tom Gurss, Ross Wolford, Julie Meyer, MBRFC
Tony Anderson, ABRFC
Paul Greer, WGRFC
Andrea Ray, ESRL & WWA

Outline

- Perspective and history
- New Capabilities
- Future Development

Western Water Supply Forecasts

- Forecasts for spring runoff amounts from snow melt dominated basins in western US
- Routinely produced at 6 RFCs and coordinated with other agencies (NRCS and California DWR)
- NWS forecast program began in 1940s
- Primary forecast tools:
  - Ensemble Streamflow Prediction (ESP)
  - Multivariate Linear Regression



Legacy Water Supply Forecast Product (Credit: NRCS / NOAA)

ESP History

- Extended Streamflow Prediction (ESP) first used at CNRFC in the early 1970s
- NWS/HRL began ESP development in 1975
- Twedt, Schaake, and Peck first presented ESP at 1977 Western Snow Conference
- ESP used for drought assessment in Washington DC in 1977
- CN, CB, and AP RFCs used ESP for water supply starting in the early 1980s
- ESP officially released in 1984 NWSRFS release
  - "ESP … has been divided into initialization and execution programs."
  - "The HCL is used to provide input to the ESP program [including] segments, historical data years"
  - "The ESP program benefits from being designed as an integral part of the NWSRFS."
- ESPADP development began in 1993; deployed to field in January 1996
- CPC Pre-adjustment developed in late1990s

Source: Day, 1985 & Laurine private communication

Twedt, et al, 1977

- “Many irrigation interests, reservoir operators, and other water management agencies now possess sufficient sophistication to demand and efficiently utilize water supply forecasts of a probabilistic nature for a variety of time periods.”
- “Because [ESP]… requires considerable amounts of historical data.. Perhaps requiring magnetic tape storage…”
- “Several final considerations involve the possible application of additional theoretical techniques such as quantitative precipitation forecasting.”

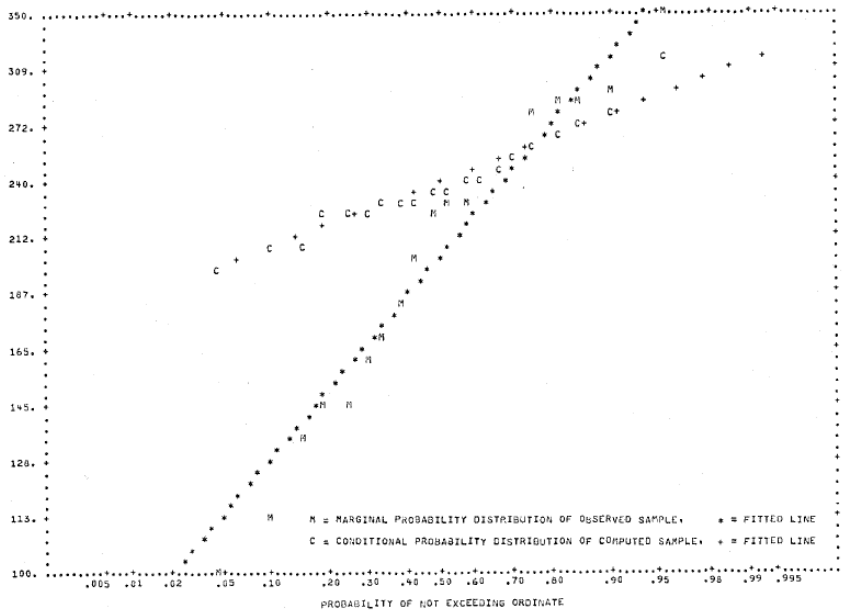


Figure 1. Marginal and conditional probability distribution plots for Eagle River total volume of flow (thousands acre-feet) during May and June 1971, predicted as of May 1, 1971.

Source: Twedt et al, 1977

Day et al, 1985

- “ESP assumes that past years of meteorological data represent possible future occurences.”
- “ESP allows a smooth transition from the forecast temperatures to the historical temperatures by providing the capability of specifying a weighting and blending period.”
- “ESP also provides the capability to blend and weight precipitation data.
- “One area of future research for ESP is the ability to incorporate knowledge of current climatology”

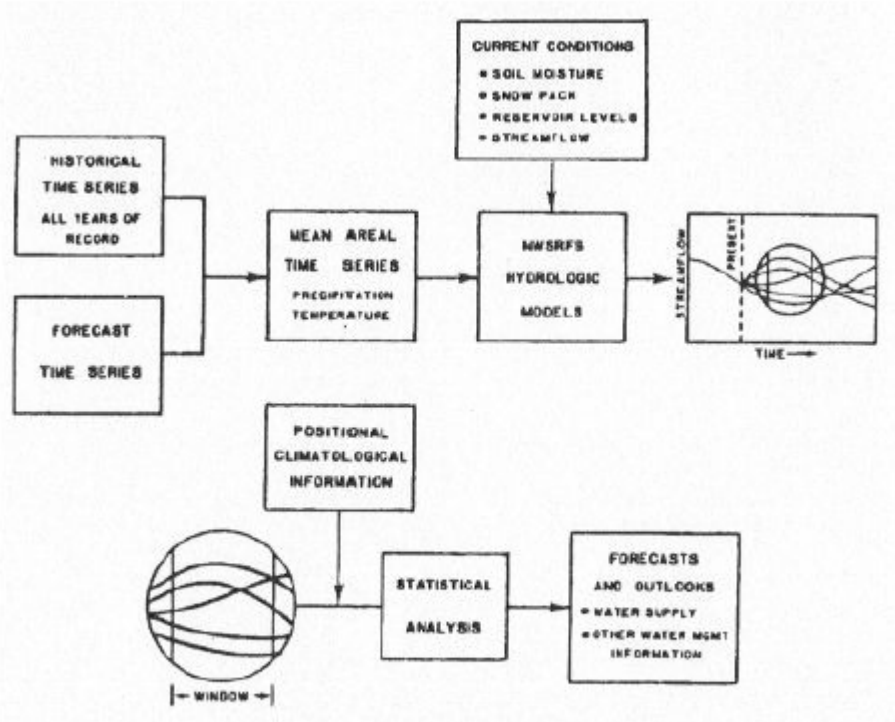
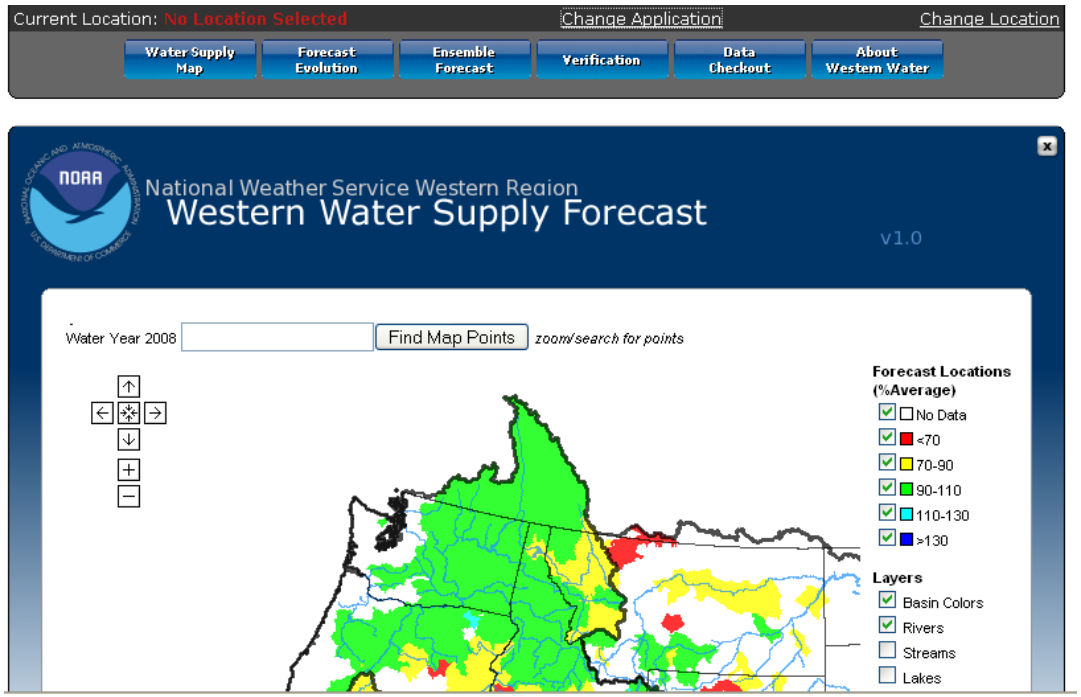


FIG. 3.—ESP Procedure

Source: Day, 1985

Project in a Nutshell
www.nwrfc.noaa.gov/westernwater



Map: Single map for all western WS forecasts from 6 RFCs

Forecast evolution: Plotting capability to show evolution of current year forecast and observed river flow

Verification: Forecast evaluation from past forecasts and forecast tools

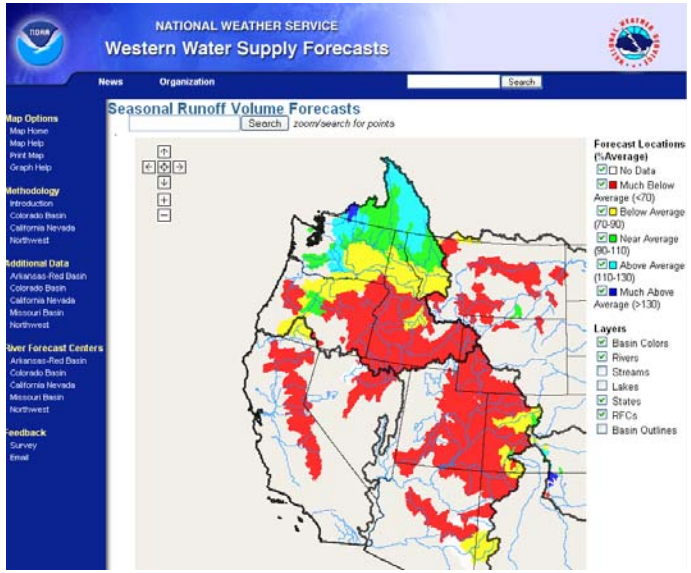
Ensemble services: Interaction capability with ensemble streamflow predication

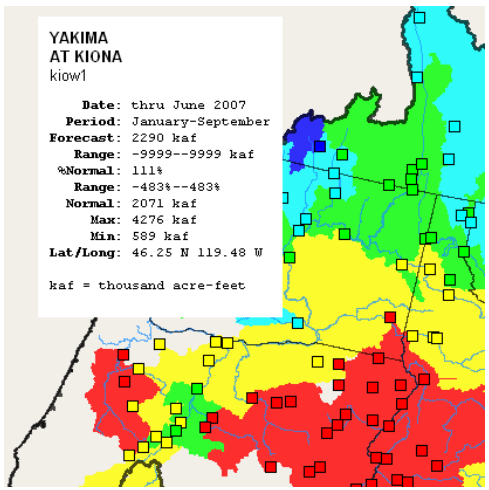
Data Access: Access data from database

Map

www.nwrfc.noaa.gov/westernwater

- "One Stop Shop" for NWS water supply forecasts
- Flexible and consistent map presence across western USA
- Zoomable to basin scale
- Mouse over capability for forecast values





Forecast Evolution

Time evolution of forecast and observed streamflow

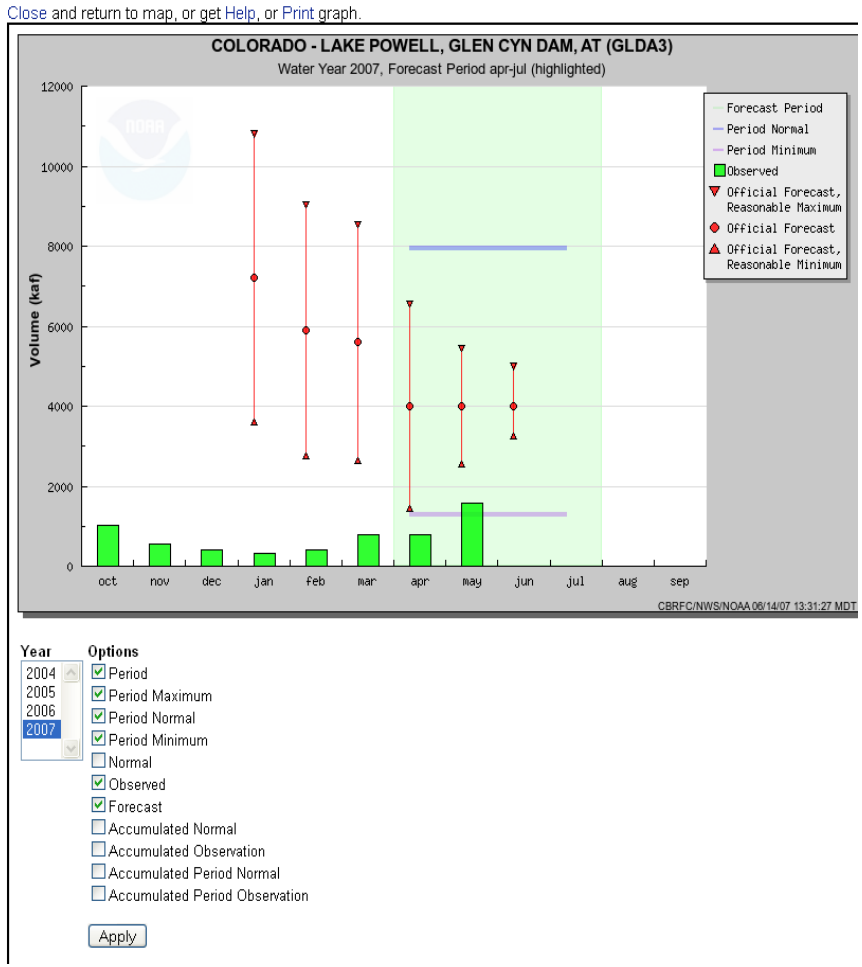
Plot options include:

-Observed monthly or seasonal streamflow

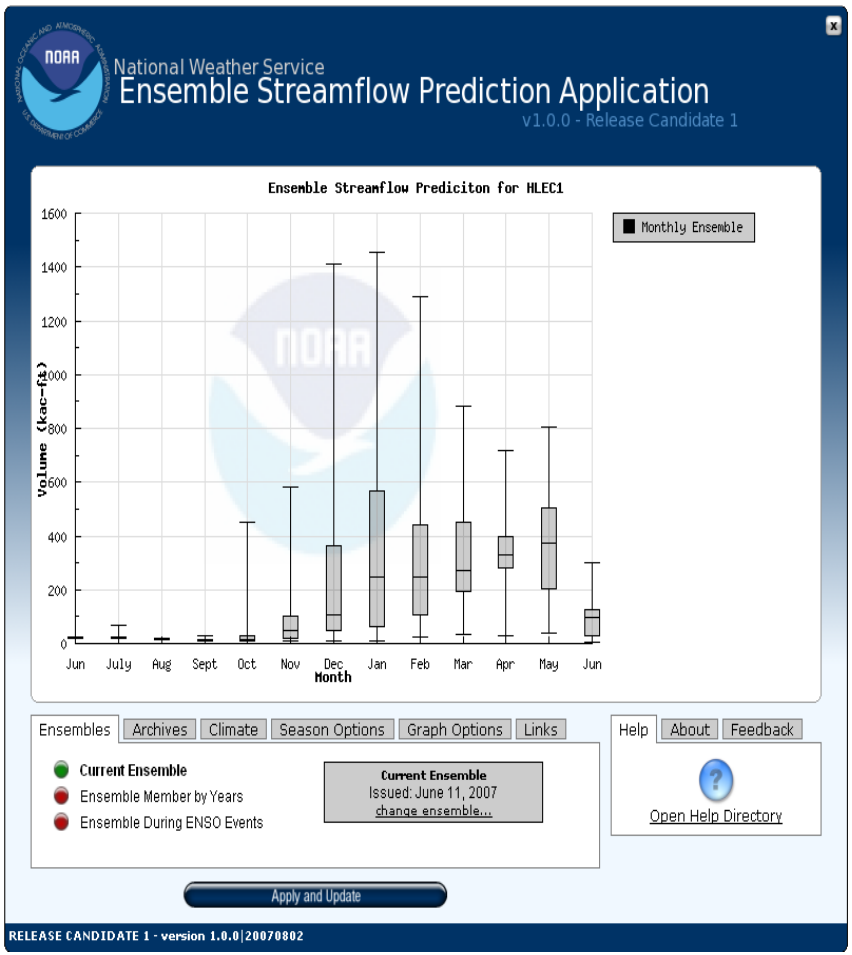
-Historical monthly or seasonal streamflow

-Forecast seasonal streamflow

-Accumulation options



Ensemble Services



RFC Ensemble Forecasts

-Initially offered at NWS water supply points

-Display probability function for monthly volumes

-Tools included to query historical data and forecast ensemble members

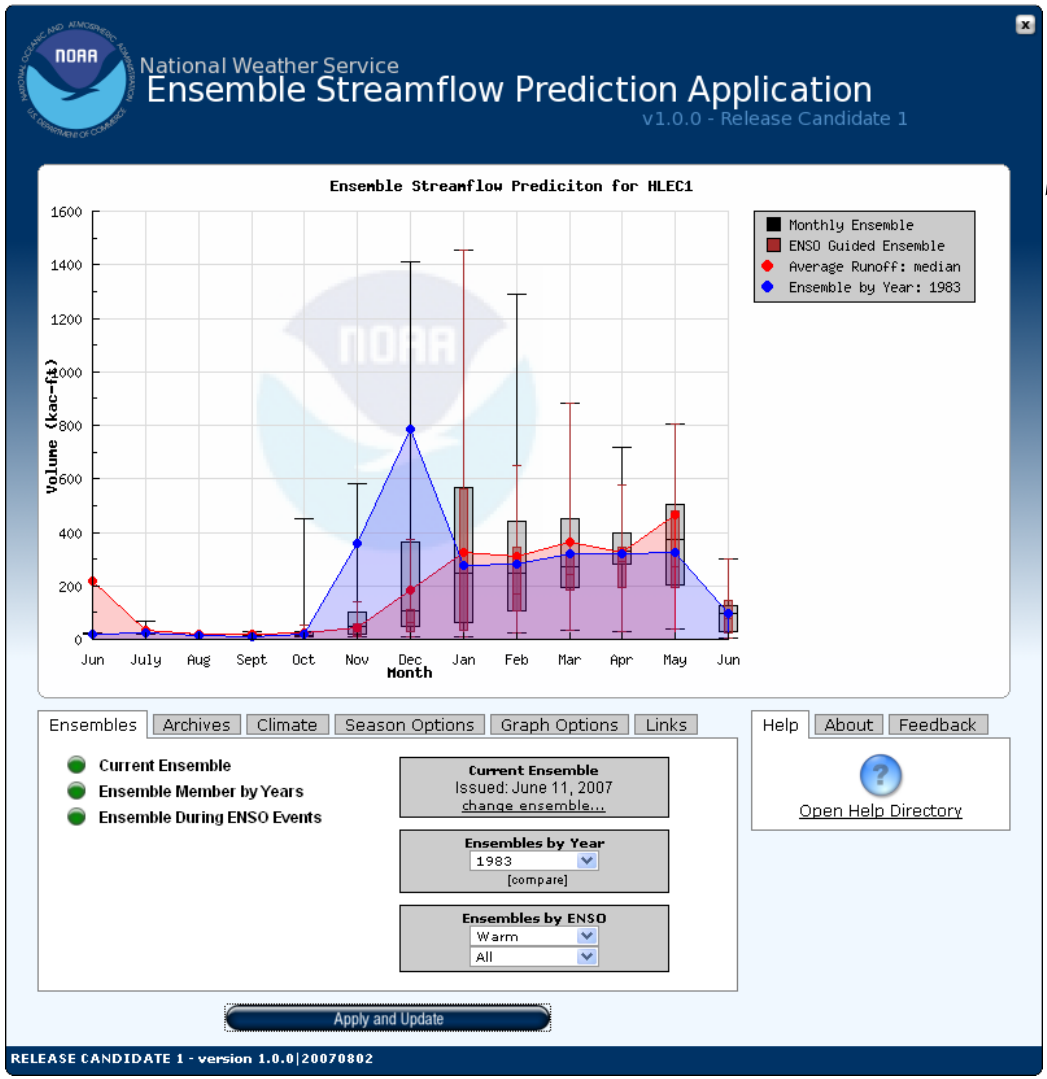
-User customizable plots

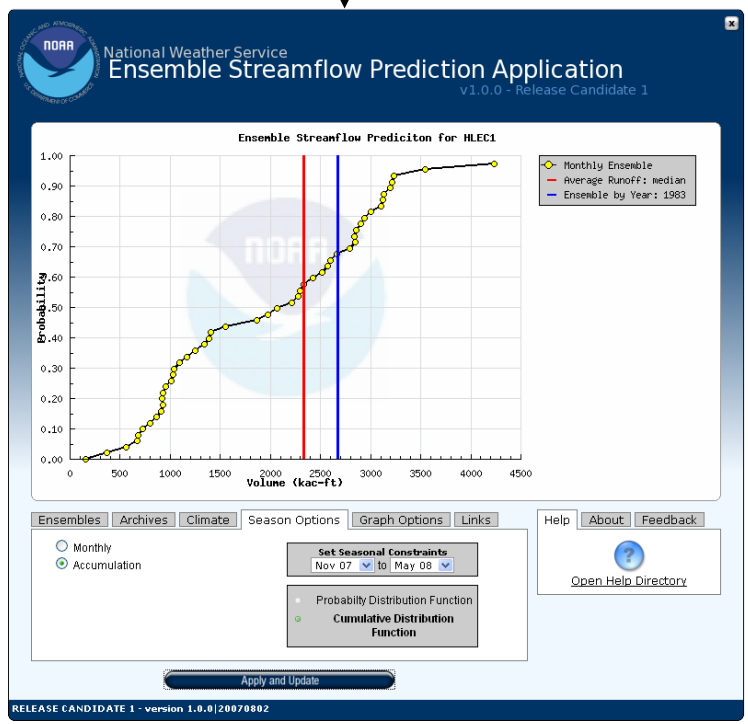
Ensemble Services

Median Historical Runoff

& 1983 ensemble member

November – May Seasonal Runoff

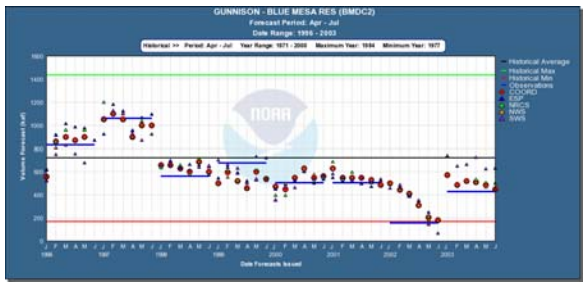




Forecast Verification

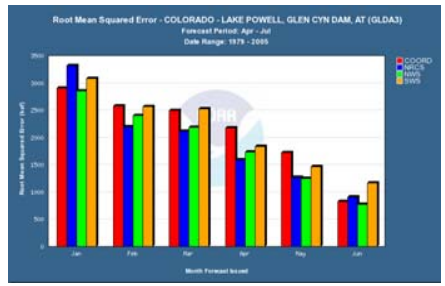
- Easy to understand
- Meaningful
- Accessible from forecasts
- Dynamically generated plots from database

Data Visualization



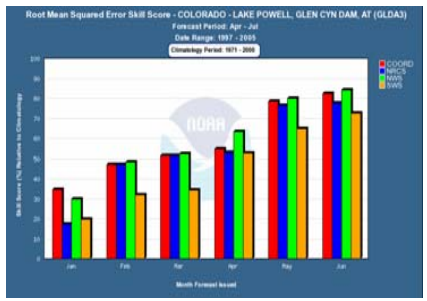
Error

- MAE, RMSE, etc
- Conditional on Lead time, year



Skill

- Skill relative to Climatology
- Conditional



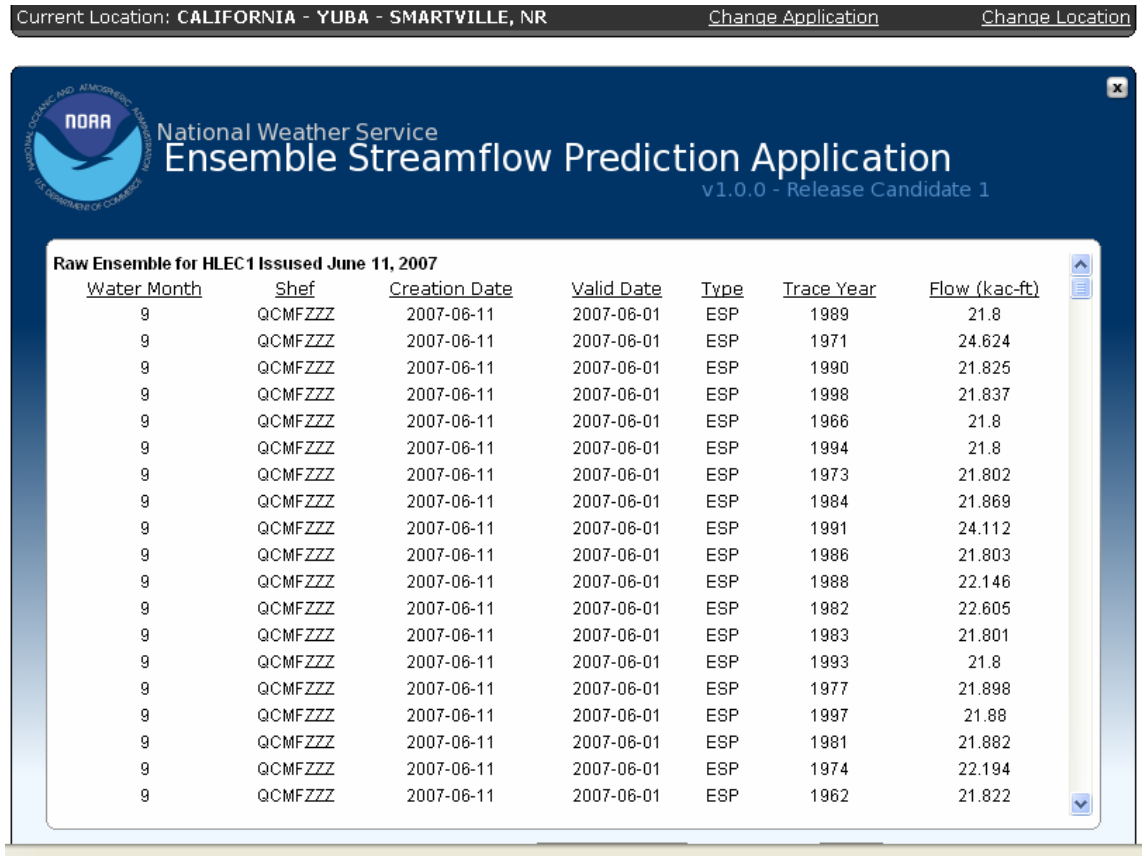
Categorical

- Traditional (NWS) verification including FAR and POD
- Category definitions tied to climatology values (e.g. mean flow, terciles, etc.) or user definable

Plot credit: Chad Kahler

Data Access

- Access to forecast and observed data from database



Raw Ensemble for HLEC1 Issused June 11, 2007

Water Month	Shef	Creation Date	Valid Date	Type	Trace Year	Flow (kac-ft)
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1989	21.8
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1971	24.624
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1990	21.825
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1998	21.837
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1966	21.8
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1994	21.8
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1973	21.802
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1984	21.869
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1991	24.112
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1986	21.803
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1988	22.146
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1982	22.605
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1983	21.801
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1993	21.8
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1977	21.898
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1997	21.88
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1981	21.882
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1974	22.194
9	QCMFZZZ	2007-06-11	2007-06-01	ESP	1962	21.822

Future Directions

Climate Change Scenarios

Forecast Ensemble Adjustment

Web Site Improvements

Couple with OHRFC, SERFC Water Resources Outlook

Link to Drought Services

Enhance Ensemble Services

Short Range Hydrologic Scenarios

Climate Variability and Hydrologic Response Relationships

Climate Change: Fresh Water Projections

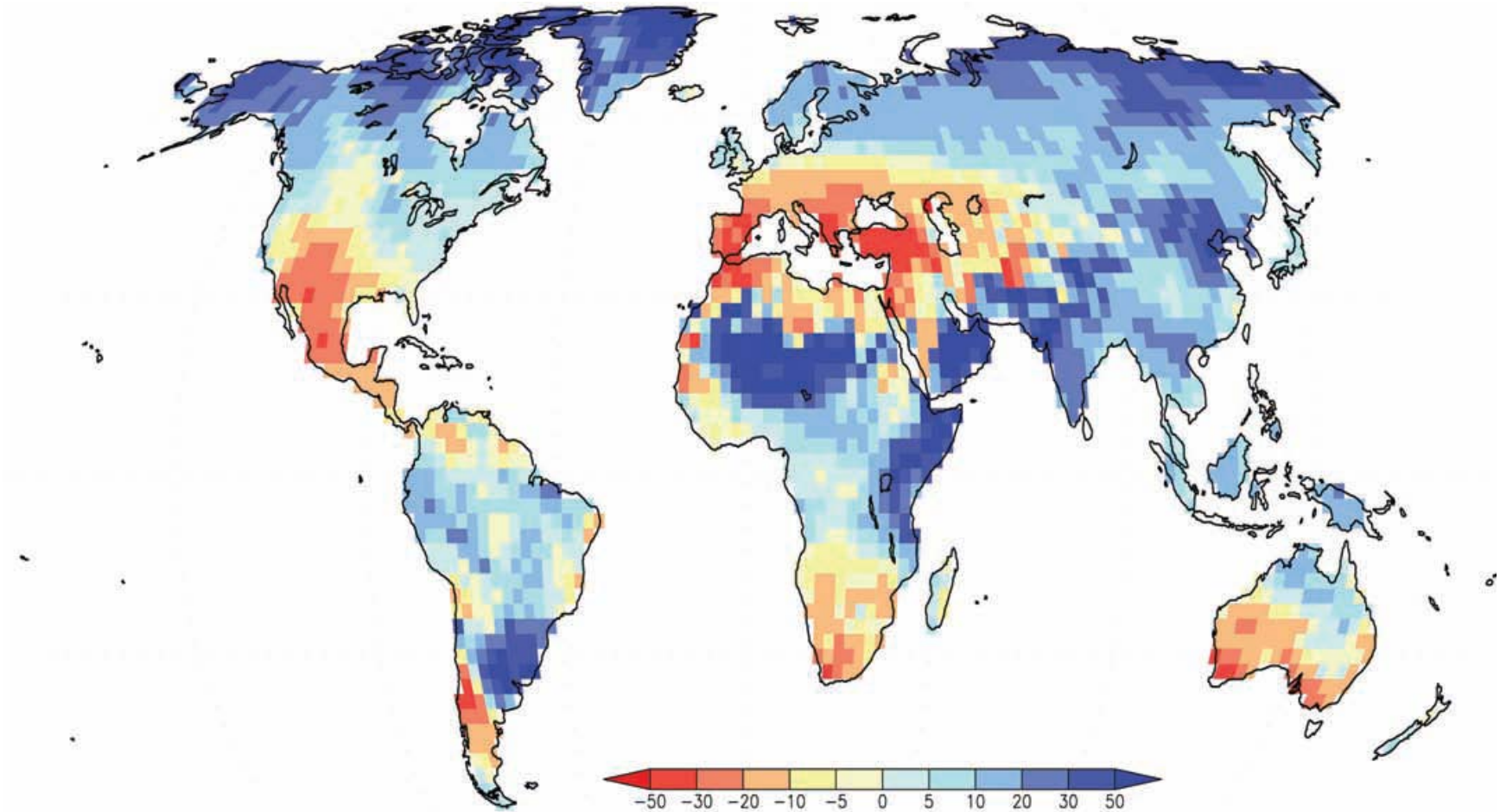
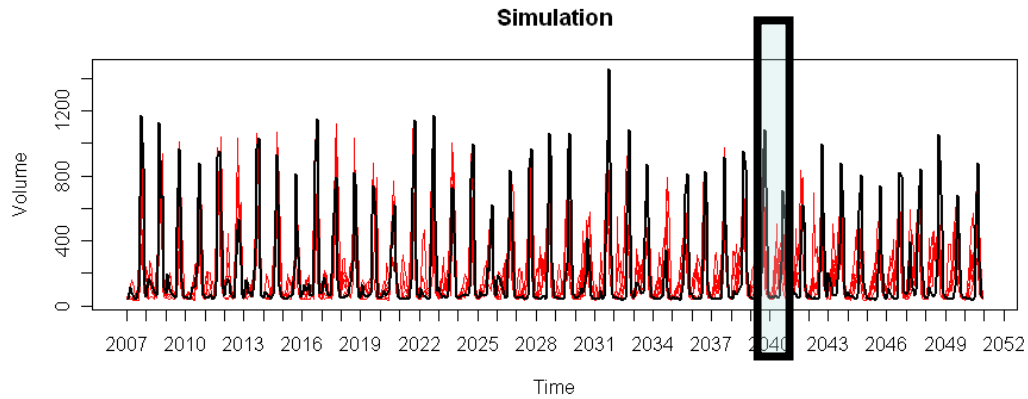
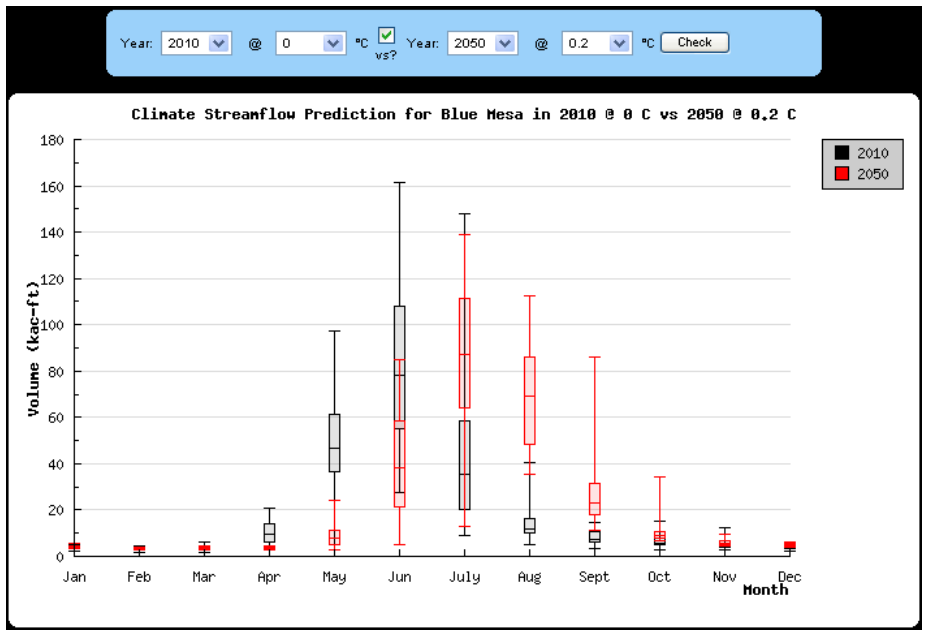


Figure TS.5 (IPCC AR4, WG2). *Illustrative map of future climate change impacts on freshwater which are a threat to the sustainable development of the affected regions.*

Climate Change Scenarios

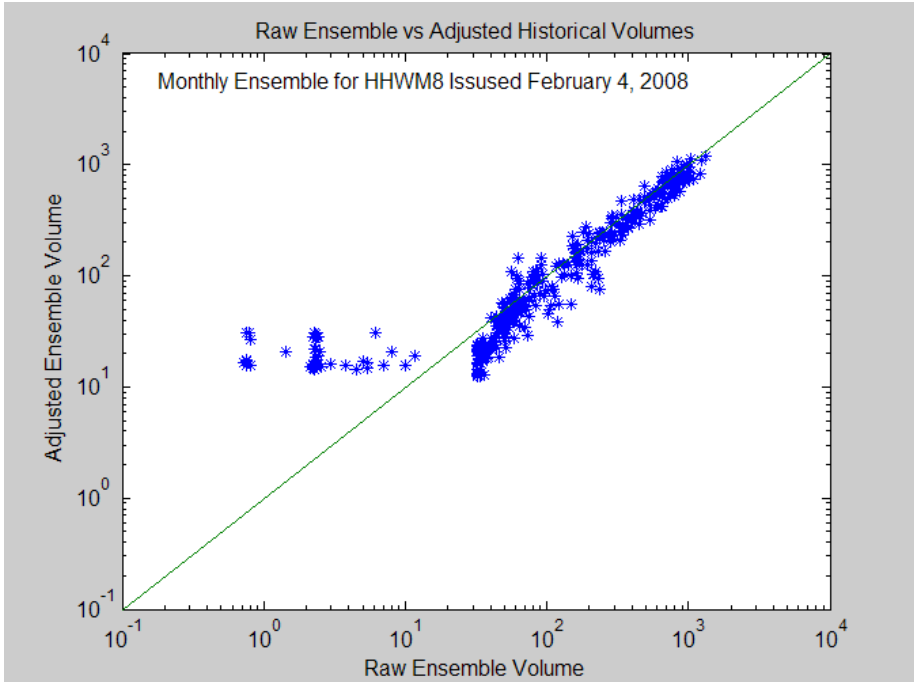


- Basin specific
- NWS ESP framework
- IPCC and/or arbitrary climate scenarios
- Probabilistic “forecasts”



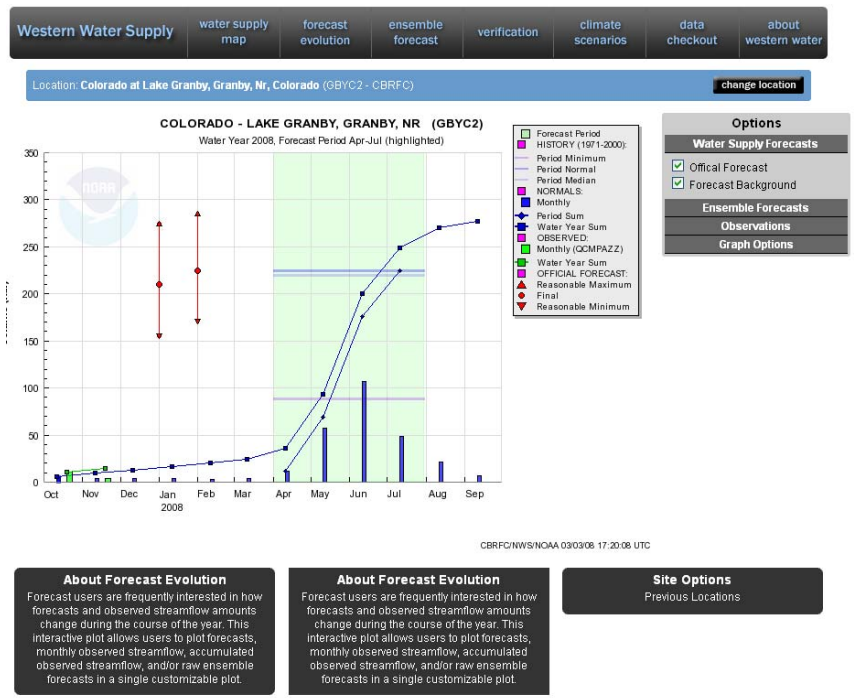
Ensemble Adjustment

- ESP forecasts typically contain biases
- In many cases, ESP forecasts may not account for all diversions and streamflow regulation that a user needs
- Post adjusting streamflow forecasts can account for these



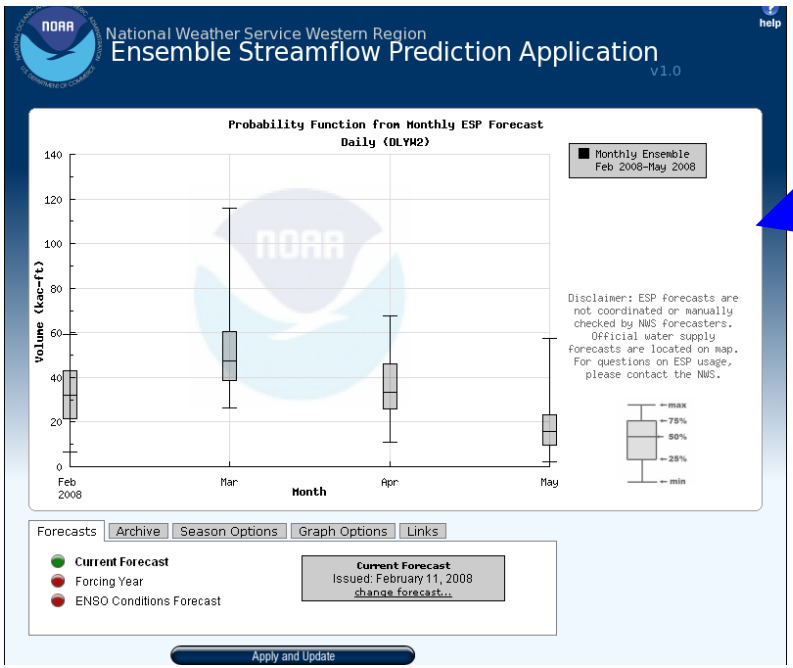
Website Improvements

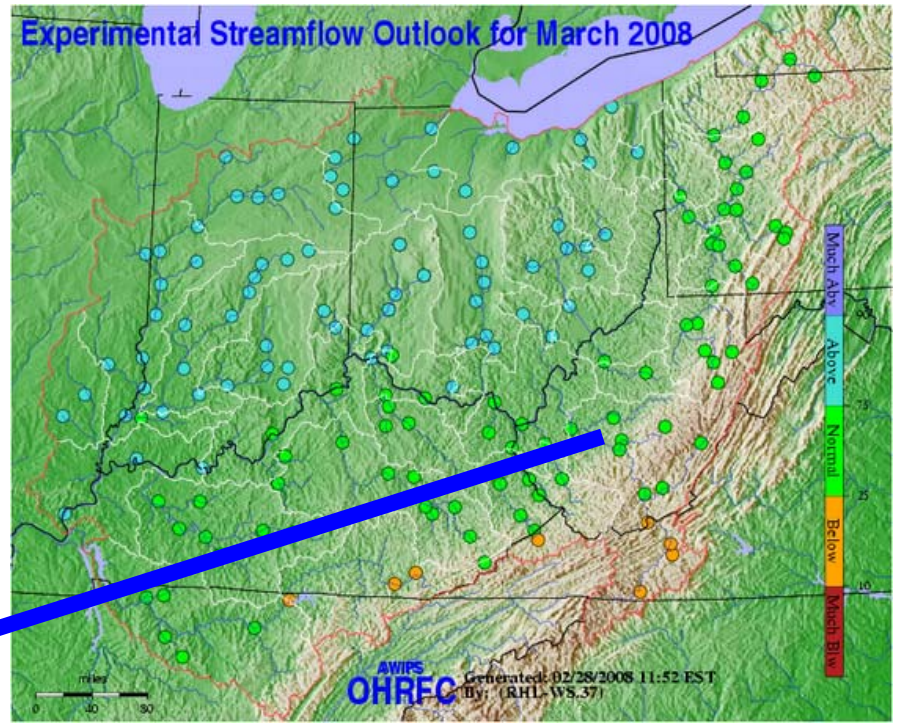
- More professional, coherent web presence
- “Smarter” handling of images and information
- Better cross linking of application capabilities to documentation
- Request and bug tracking system



Link with Water Resources Outlook

- Link to OHRFC, SERFC developed water resources outlook





NWS Western Water:

www.nwrfc.noaa.gov/westernwater

Questions? Feedback?

Kevin.werner@noaa.gov